

Mechanical Characterization of An Epoxy Composite

Author: Dr. Max Dehghan
www.excelplas.com

05/07/17

Prepared for Sarier Brothers Trading Pty. Ltd.
Excelplas Job # 6673



Accredited
Laboratory
ISO/IEC 17025

Client Details

Client Contact Details:

- Gavin Li
- Sarier Brothers Trading Pty Ltd
- M. +61 4 4991 1939
- E. gavinli811@gmail.com

Objective

The objective of this study is to conduct quality assessment of an epoxy composite sample.

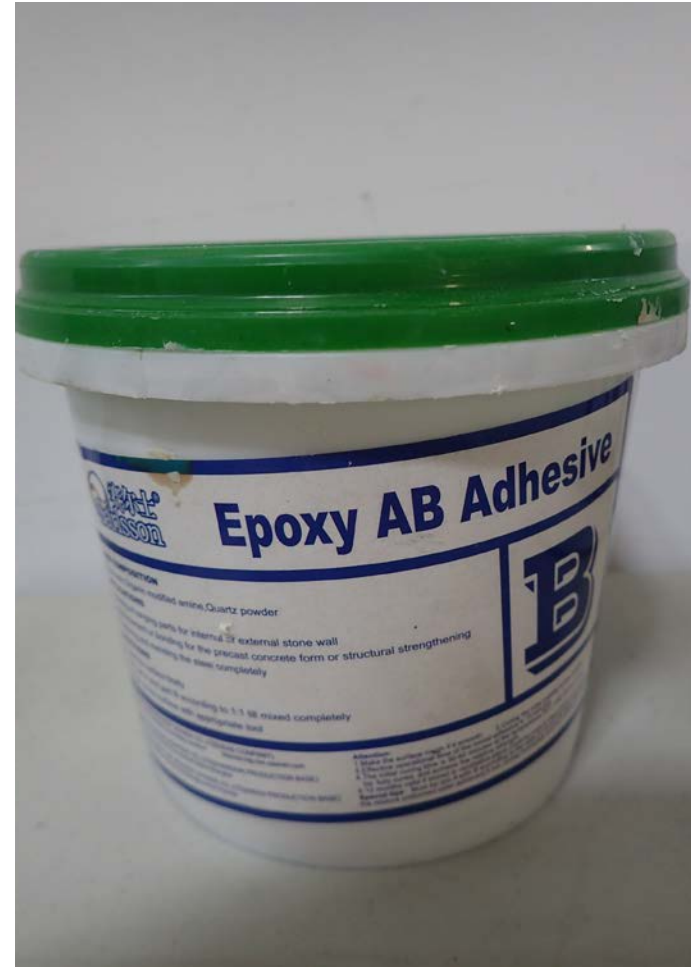
Samples received

- The following sample was received from Gavin Li of Sarier Brothers:
 - One container of Part A epoxy (resin)
 - One container of Part B epoxy (hardener/during agent)
 - Marbles and tiles (for bond test)

As-Received Sample

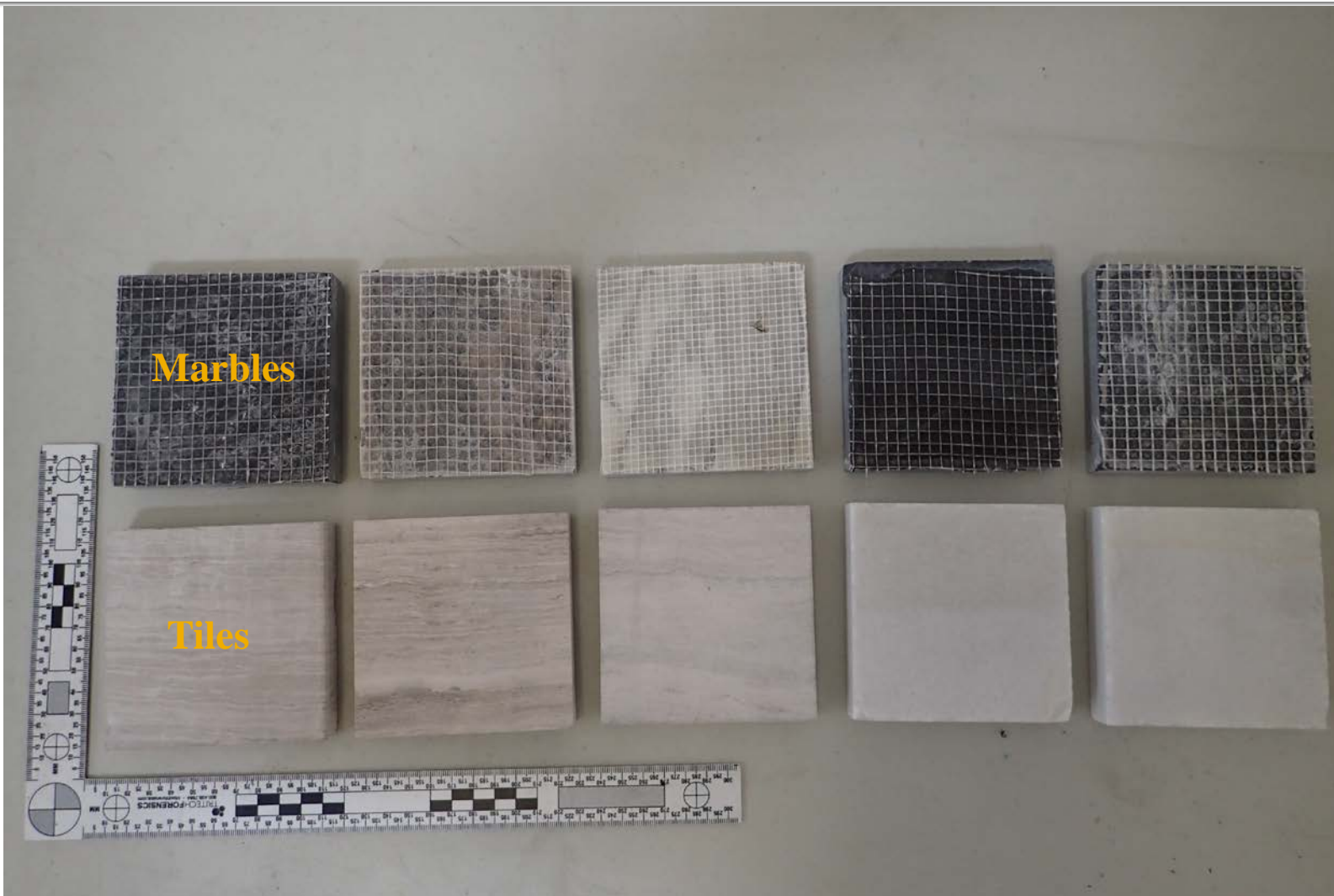


Part A (resin)



Part B (hardener)

As-Received Sample



Instructions Received

- ExcelPlas has been asked to undertake mechanical characterization of a two part epoxy system.

“Instructions received by email from Gavin Li of Sarier Brothers on 23 June 2017”

Experimental Methods

The following testing was performed:

- Density (**ASTM D 792**)
- Tensile (**ISO 527-2**)
- Flexural (**ISO 178**)
- Compressive Strength (**ASTM 695**)
- DSC – (T_g)
- Bond Strength to Marble/stone (**modified ASTM 1002**)

Methodology - Density

- Testing was conducted according to ASTM D792–13 Standard Test methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

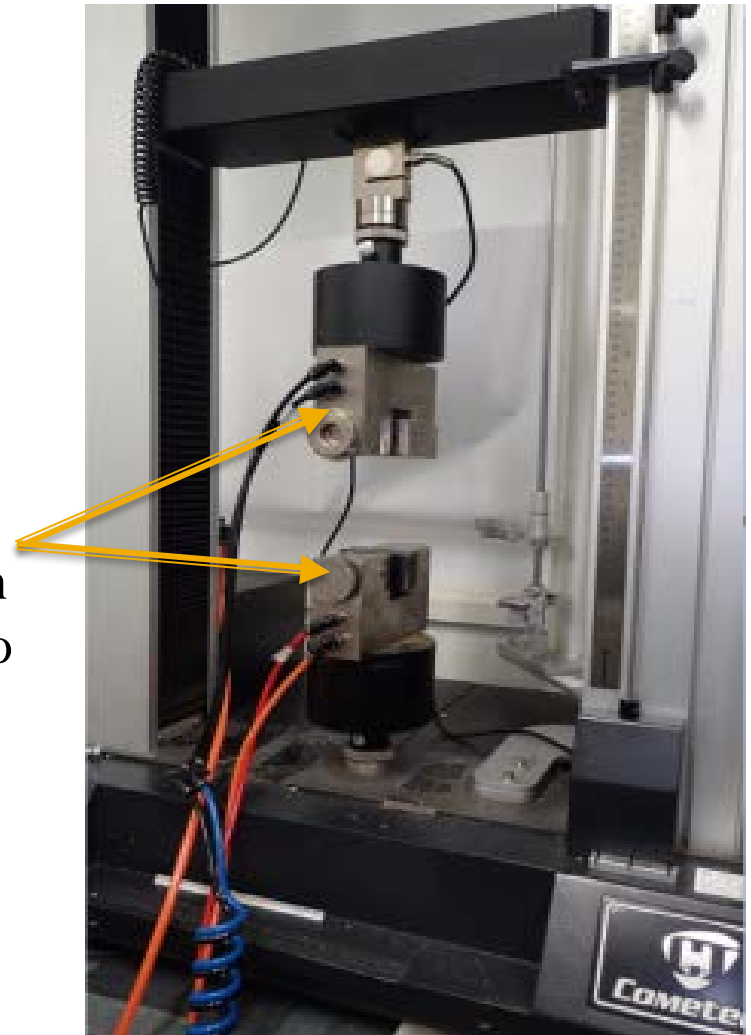
The density apparatus used was an Archimedes Bridge displacement type A&N Model GF-300 S/N T0303404.



Methodology - Tensile

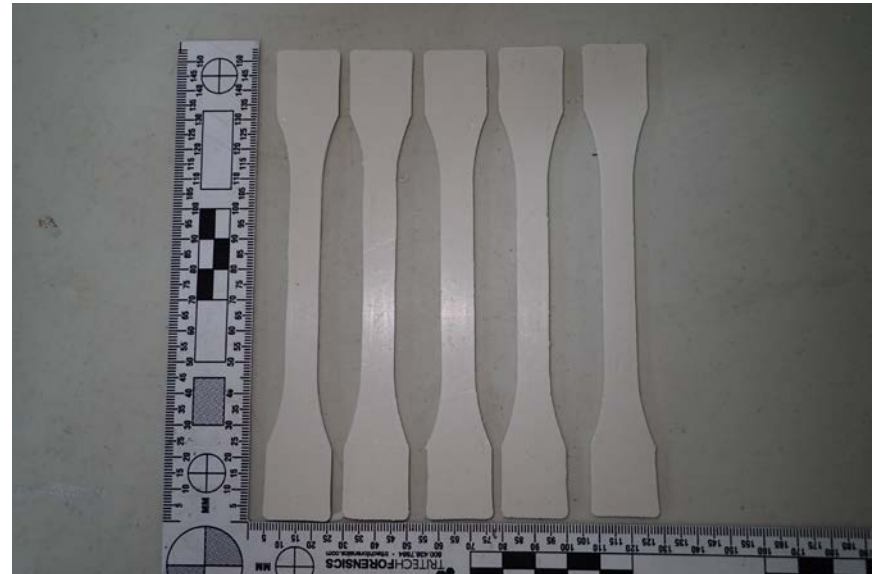
- Tensile tests were performed using tensile testing instrument (50A1-112012).

Tensile grips
(specimen is fixed in
the grip and pulled to
break)



Methodology - Tensile

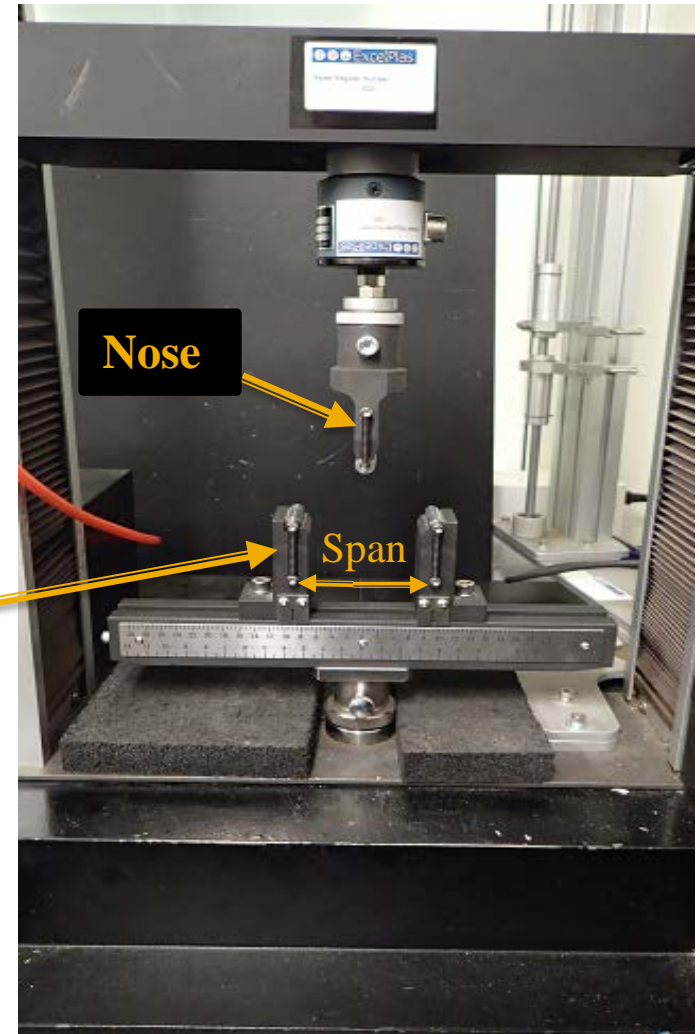
- Tensile test specimens were prepared by mixing part A and B and pouring them into the moulds prepared according to ISO 527-2. The specimens were then demoulded after complete curing. Testing was conducted after the specimens were conditioned according to ISO 527-5.



Methodology - Flexural

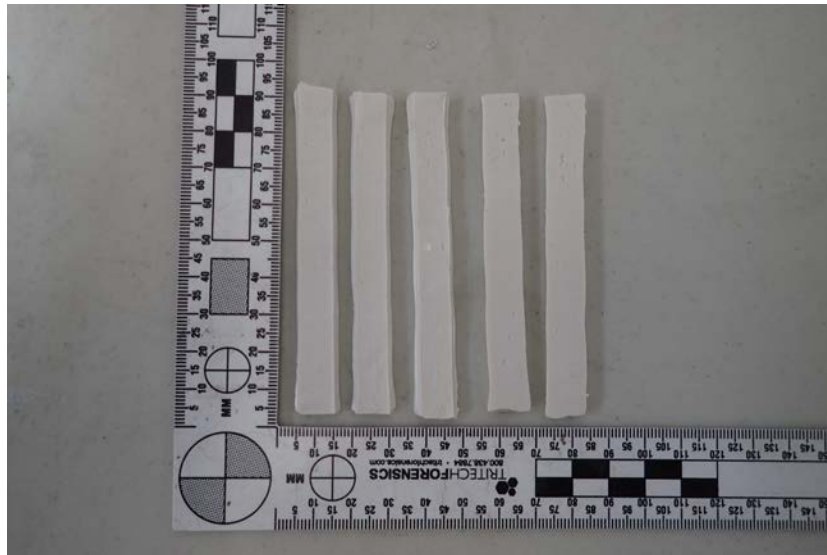
- Tensile tests were performed using a tensile testing instrument (50A1-112012) with the three point bending flexural test rig installed on it.
- Span : 48 mm

Flexural test rig
(load is applied on
the sample using the
nose)



Methodology - Flexural

- Tensile test specimens were prepared by mixing part A and B and pouring them into the moulds prepared according to ISO 178. The specimens were then demoulded after complete curing. Testing was conducted after the specimens were conditioned.



Methodology - Flexural

- Flexural Stress (σ_f) was calculated using the below equation:

$$\sigma_f = \frac{3FL}{2bh^2}$$

where

F is load (N);

L is the span (mm);

b is width (mm);

h is thickness (mm)

Methodology - Compression

- Compression test was conducted by mounting a compression subpress (1" Diameter, NO. WTF-SP-58) on the tensile machine.



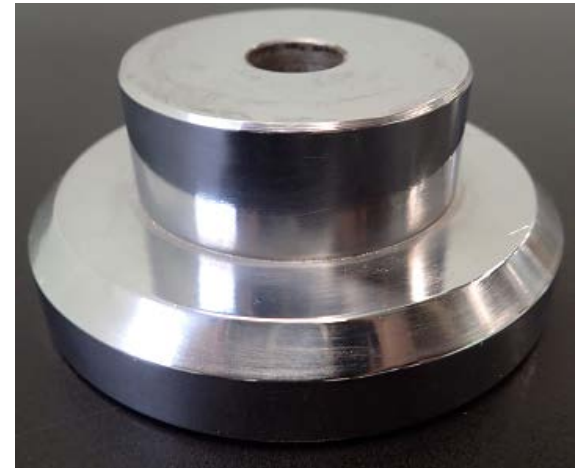
Methodology – DSC

- T_g measurement was conducted using a TA DSC instrument (QA-20).



Methodology – Bond Strength to Marble

- Specimens were prepared by applying the adhesive on to the marble surfaces using a trowel. Tiles were attached on to the marble specimens by applying approximately 20 N using the weight shown in the picture.
- The specimens were then left to be cured.



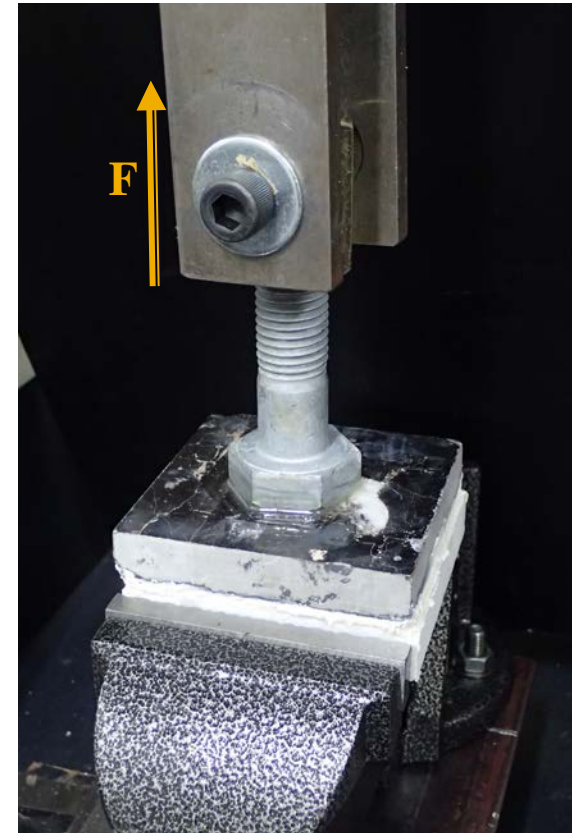
Methodology – Bond Strength to Marble

- After complete curing of the adhesive, bolts were glued onto the tiles using Araldite resin.



Methodology – Bond Strength to Marble

- Test was performed by pulling off the glued bolt on the tile using a tensile machine.



Test Results - Density

ExcelPlas Pty. Ltd.			
Density			
ASTM D 792			
Raw Data Form			
Apparatus Identification	QC-tech GF-300 OP-13 S/N T0303404		
Client	Sarier Brothers		
Job Number	# 6673		
Sample Name	Epoxy		
Batch Number			
Tested by:	MD		
Date of Test	30/06/2017		
Temperature of Test °C	23		
Specimen 1 Density (gram/cubic centimetre)	1.838		
Specimen 2 Density (gram/cubic centimetre)	1.831		
Specimen 3 Density (gram/cubic centimetre)	1.840		
Mean Density (gram/cubic centimetre)	1.836		
Standard Deviation (gram/cubic centimetre)	0.005		
Evidence of Specimen Porosity	slightly porous		

Test Results - Tensile

Tensile Testing of Composite materials (ISO 527-2)

Epoxy Composite

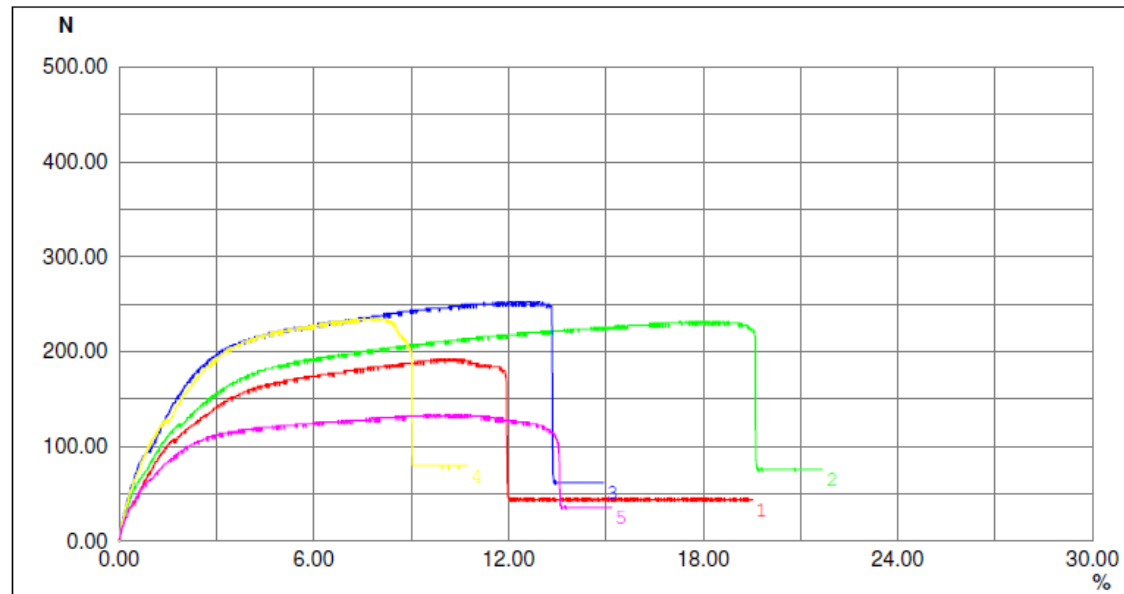
Customer : Sarier Brothers

Job Number : 6673

Test Date : 30/06/2017

Conditioning : 4 days @ 23C and 50% Humidity

No	Maximum Force N	Tensile Strength MPa
1	192.00	10.91
2	232.00	13.18
3	252.00	14.31
4	236.00	13.41
5	134.00	7.61
Mean	209.20	11.88
Std	47.49	2.41
Min	134.00	7.61



Tensile Result Summary

- The average tensile strength was measured to be approximately 12 MPa, however by disregarding the result obtained from the last specimen (smaller than the average value) the average tensile strength will be 13 MPa.

Test Results - Flexural

Flexural Testing of Composite (ISO 178)

Epoxy

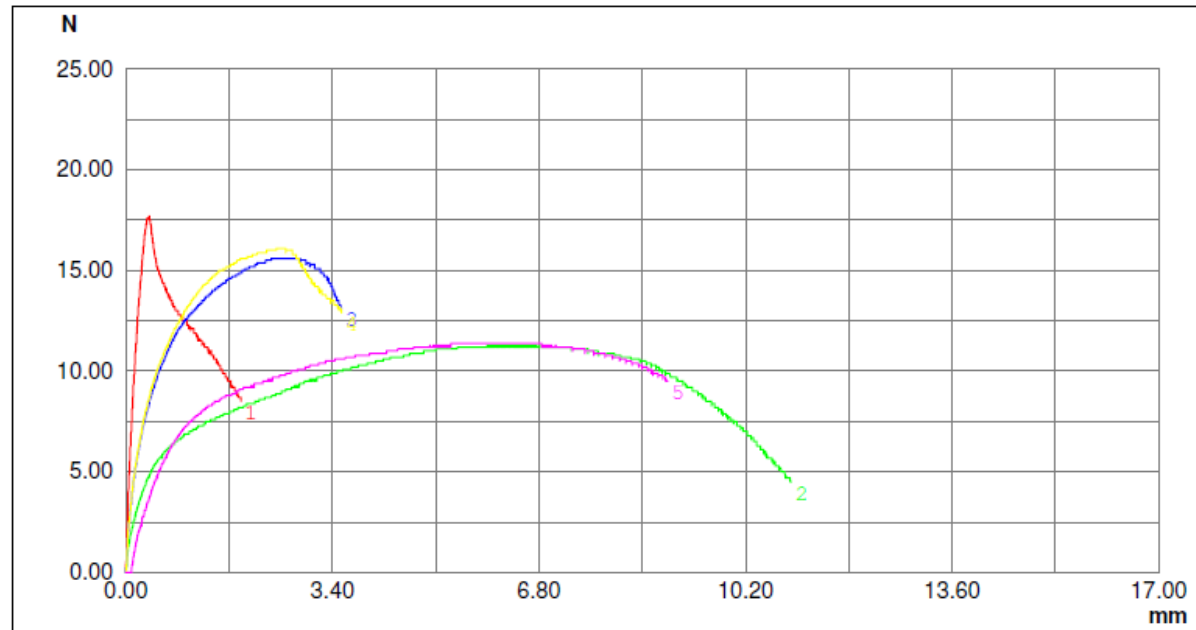
Customer : Sarier Brothers

Job Number : 6673

Condition : 4 days @ 23C & 50% Humidity

Test Date : 29.06.2017

No	Maximum Force N	Flexural Stress MPa
1	17.70	14.16
2	11.30	9.04
3	15.60	12.48
4	16.10	12.88
5	11.40	9.12
Mean	14.42	11.52
Std	2.91	2.08



Test Results - Compression

Compression Test - ASTM D695

Epoxy Composite

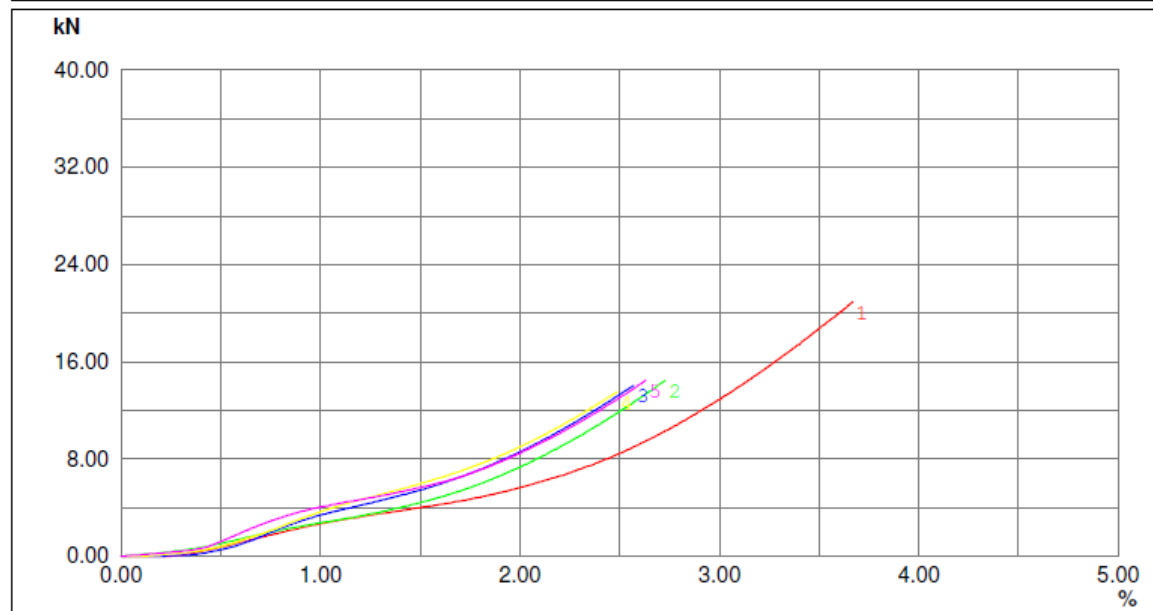
Client : Sarier Brothers

Job # : 6673

Test Date : 03/07/17

Conditioning : 4 days @ 23C , 47% Humidity

No	Yield Force kN	Strength at Yield MPa
1	3.78	82.80
2	3.44	75.35
3	4.16	91.13
4	4.75	98.14
5	4.41	96.60
Mean	4.11	89.99
Std	0.23	8.60
CV %	81.01	75.35

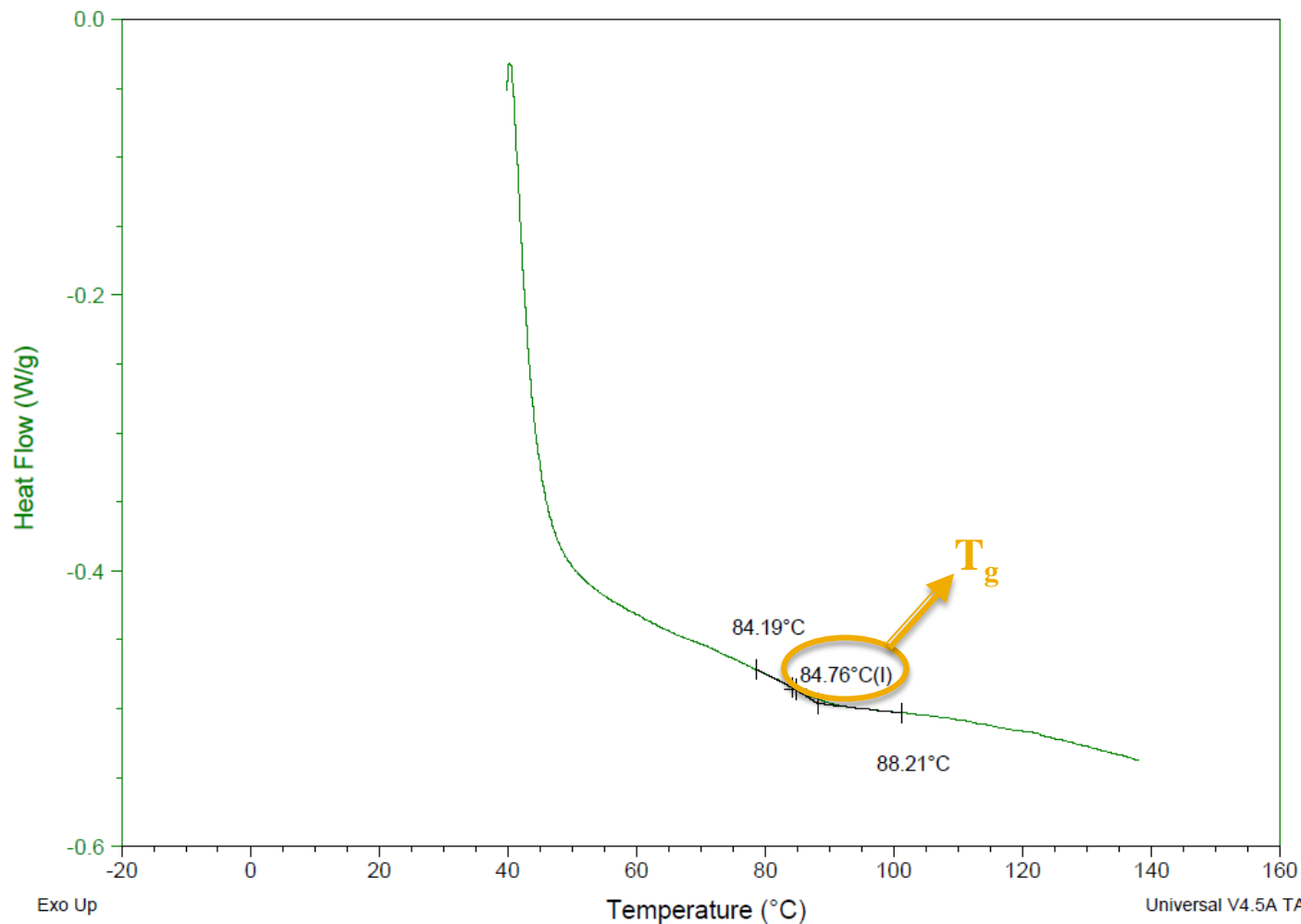


Test Results - DSC

Sample: 6673 Tg - 2
Size: 14.0000 mg
Method: Glass Transition (Annealed)

DSC

File: C:\...\6673 Tg - 2.001
Operator: MD
Run Date: 30-Jun-2017 15:36
Instrument: DSC Q20 V24.11 Build 124



Test Results – Bond Strength

Bond Strength of Epoxy Adhesive Marble/Tile Bond

Client : Sarier Brothers

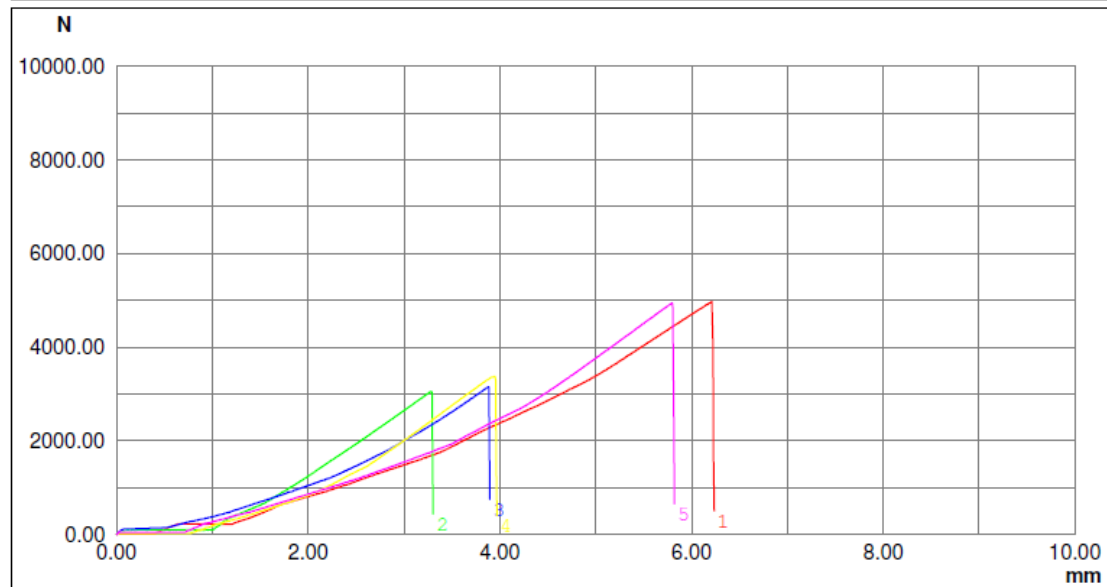
Job # : 6673

Conditioning : 4 days @ 23C 50% Humidity

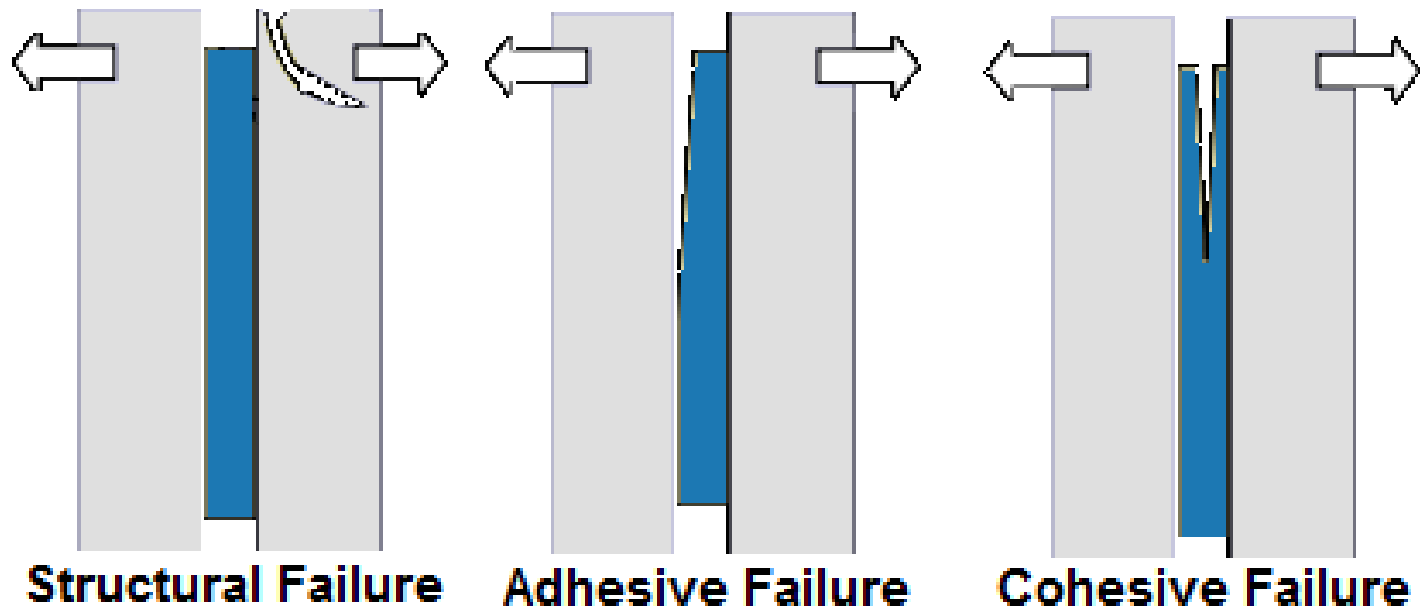
Test date : 04/07/17

Machine Model : Cometech 20kN

No	Maximum Force N	Strength
		MPa
1	4978.00	11.99
2	3066.00	7.38
3	3162.00	7.61
4	3376.00	8.13
5	4956.00	11.94
Mean	3907.60	9.41
Std	973.62	2.09



Adhesive Failure Modes



Failure Mode of the Tested Samples

- The failure mode of the specimens was a combination of “structural” and “adhesive”.



Adhesive failure mode

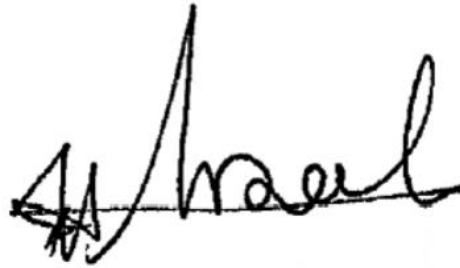


Structural failure mode

Results summary

Property	Average value obtained
Density (g/m ³)	1.84
Tensile Strength (MPa)	13
Flexural Strength (MPa)	11.5
Compression Strength (MPa)	90
Glass Transition Temperature (°C)	85
Bond Strength to Marble (MPa)	9.41

Contact Details of Author



Masoud (Max) Dehghan, PhD in Materials Sci. Eng.
Business Development Manager
max@excelplas.com

ExcelPlas Pty Ltd

Head Office and Deliveries:
473 Warrigal Road (Rear Factory)

Postal Address:
PO Box 147

Moorabbin VIC 3189
Australia
p. +61 3 9532 2207
w. www.excelplas.com

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